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PREPARED

FOR VARIOUS OCCASIONS

BY

JOSEPH B. WALKER

OF

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AN ADDRESS

UPON

LAND DRAINAGE,

BY

JOSEPH B. WALKER.

DELIVERED BEFORE SEVERAL AGRICULTURAL MEETINGS DURING THE WINTER OF 1870-71.

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ADDRESS.

Sir Walter Scott used to say that "There was nothing more conducive to a man's health than a walk of a mile before breakfast, particularly if over his own land." Confident that there is truth in this remark of the great novelist, I invite you to a stroll this morning over the bogs and marshes and drenched meadows of our own state, hoping that repeated mirings and successive leapings of sluggish streams may not only afford wholesome exercise, but convert you all to a belief in thorough drainage.

The census returns of the year 1870 are not particularly flattering to our New Hampshire agriculture. One hundred and seventy-seven towns have now a less population than they had ten years ago, and these are all, or nearly all, farming towns. The war called away many of their most vigorous sons and only a part of them have returned. The superior attractiveness, real or fancied, of other pursuits have caused the removal of some, while the cheap, rich lands of the west have induced the emigration of others still. Now, in many sections, farming languishes. Buildings and fields show signs of neglect. Labor, scarce and dear, is not unfrequently performed in great part by old men and boys. It seems at first glance as though the great leading interest of the state was declining and passing under a cloud.

But it is unmanly to take counsel of our fears or to yield to temporary despondency. While some localities may have diminished their population, others have increased theirs. People are gathering more than formerly at important centres, and along the lines of railways, and many of our towns show an important increase during the last decade. Much, indeed, of the loss at which we sigh and shrug our shoulders, is more apparent than real — a simple movement of population from one locality to another more inviting.

Yes, it is a mistake to despond of our husbandry. Its future will be just what the farmers of New Hampshire resolve to make it. Many vicious practices and erroneous notions, that have long prevailed to our hurt, will doubtless die, and ought to die, but from their ashes, Phœnix-like, will arise others to gladden our fields and rejoice our hearts. Our agriculture is just now in a transition state, from a lower to a higher plane, and at the very point of its passage at which it needs the aid of clear heads, willing arms and energetic souls to lift it into regeneration and a prosperity commensurate with its importance. To secure this result we must farm better than we have been wont to do. We must cultivate better our tillage lands; we must improve our pastures; we must devote more care to our herds, and learn to appreciate the difference between a mongrel and a thoroughbred animal; we must reclaim and drain our wet lands and make every acre, whether water, land, or mountain crag, produce something.

I am aware that drainage has had sturdy opponents, as well as earnest advocates. There is a kind of conservatism in the world which inclines men to take things as they are and to keep them so. You remember, perhaps, the deprecatory remark of Aunt Dorothy to her niece, reported to us by Mrs. Charles in her "Draytons and Davenants," when a few years before the protectorate, Oliver Cromwell called at her brother's house in the fen country, where they had often talked upon this very subject. "I can't think why they wont let the fens alone. They did very well for our fathers as they were, and they were better men than we see now-a-days; and if the Almighty made the fens wet I suppose he meant them to be wet." With profoundest reverence for the opinions of Aunt Dorothy, we are constrained to differ from her on this point, and conscientiously believe He did not mean them to be forever wet.

The wet lands of this state are of much greater extent than is generally supposed, and I hazard little, I think, in saying that twenty per cent. of all its lands would be improved by thorough drainage. A moment's reflection will call to your remembrance their varied character. Some are abandoned river channels, now elevated above the ordinary level of neighboring streams by successive crops of aquatic vegetation, or by alluvial deposits, or by both; having a soil of great fertility, which, enriched annually by freshets, is capable of bearing abundant crops for generations.

Some are bogs composed entirely of vegetable matter, situated in valleys and basins, to which the surrounding hills afford extensive

water-sheds which precipitate upon them every shower that falls, as well as the melted snows of every winter. These abound in numerous elements of fertility, but unimproved are worthless and inaccessible. Many of these, partially drained and cleared, produce full crops of aquatic grasses, but of slight value as herbage or as the bases of manure. Some of them are still in the forest and sparsely covered with bushes and sickly growths of scattered trees. Others are lands of good quality but continually drenched by the constant overflow upon them, at the sides or from beneath, of springs, which render comparatively futile all attempts at successful cultivation. Others still, being upon hills and high swells, are kept continually wet by the compact or clayey nature of their soils or from being underlaid by subsoils impervious to water. Not unfrequently small patches of these disfigure the beauty of the best fields of a farm, or separate them from one another by an impassable bog.

We have no data from which to estimate exactly the aggregate area of these lands, but general observation establishes the fact of their great extent. Rich, in localities where often rich lands are rare, and in many respects the most fertile of any we have, they are producing very little of value to man or beast; for, while no important farm plant can grow without water, none can grow in or under water. Their thorough improvement would double the hay crop of the state, and increase immensely its other agricultural products. The first step in this direction is their

DRAINAGE.

This, as just intimated, is no new invention. It is as old, probably, as agriculture. The Romans practised it, and their writers upon husbandry: Cato (B. C. 234), Palladius (B. C. 350), Columella (A. D. 42), and Pliny (A. D. 23), make repeated mention of it. Varro (B. C. 116), the friend of Cicero, says that in September "you must dig new drains and scour the old ones." Some of them give directions for the construction of drains of stones, faggots and straw, detailing the different methods then in use.

Our English forefathers made use of it at an early period. In the last days of Queen Mary (1557), quaint old Thomas Tusser, in his homely but sensible doggerel, told the farmers of his day that

"The fen and the quagmire, so marish be kind,
And are to be drained, now win to thy mind;
Which yearly undrained, and suffered, uncut,
Annoyeth the meadows, that thereon do 'but."

This, doubtless, was open, shallow drainage, and we hear little, if anything, of a deep and thorough kind, until, some two hundred years later, Captain Walter Bligh published an important work upon the subject (1752), called "The English Improver, Improved," wherein he discussed the subject very fully and said, among other things, "Only make thy drayning trenches deep enough and not too far off thy floating course and I'll warrant it they drayn away that under moisture, fylth and venom," and to clinch his proposition triumphantly remarked, in the language of Bildad to Job, "Can the rush grow up without mire? can the flag grow without water?"

The doughty captain was certainly right, and if we can only "drayn away the under moisture, fylth and venom" from our wet lands, they will be at once docile to manipulation and vie with the prairies in fatness.

Draining with tiles is of later date. Indeed, we hear but little of their use before the beginning of the present century; since then, they have been extensively employed in England and a good deal in this country. Mr. Henry Coleman tells us that, twenty years ago, the Duke of Portland had seven thousand miles of tile drains upon his estates alone, and he is but a single one of the great proprietors who have, of late years, been enhancing the value of English land by drainage.

Mr. John Johnson, a Scotch farmer living in Seneca County, New York, was the first to introduce tile draining into the United States, commencing it upon his farm in 1835. His example was soon followed by others in different sections of the country. The first used in New Hampshire were brought from Albany, some twenty years later (1854), by William Conner, of Exeter, and used upon his land in that town. The year following, Judge French, then residing there, imported more of them and was subsequently instrumental in encouraging their manufacture at Exeter, where they are still made.

Thus far, drainage has been practiced more abroad than with us. Density of population and dearness of land accounts in part for this fact. In Great Britain, extensive drainage enterprises of a public character, also, have been instituted, aided in some instances by the government.

In Holland the Polders afford much of its most productive soil worthless, however, but for persistent drainage. About a score of years ago the whole bed of Haarlem Lake was laid bare, through the gigantic agency of immense steam pumps, and an area of forty-four thousand five hundred and twenty acres, before submerged to a depth of fourteen feet, was made dry land, at an expense of $80.69 per acre.

EFFECTS OF DRAINING.

The effects of drainage are several and very marked:

1. It renders the land accessible at all seasons of the year. Most swamps and bogs are so soft and miry that, previous to drainage, all attempts at cultivation were vain, many of them being at times so flooded as to render necessary the removal of the wretched grasses they produce by human effort and upon poles. If, perchance, at a dry season of the year it be possible to plow, manure or re-seed them, it will be of little use, for the dressing will be washed out by the next flooding and the lightened soil soon settle down as sullen as before; while all tame grasses sown upon them, after a brief and unequal contest, will yield the ground and disappear. Properly drained the same land can be worked at pleasure; fertilizers will show themselves as quickly and as long as on soils needing no draining, and crops before impossible grow luxuriantly.

2. Drainage, too, prevents that maceration of the roots of plants so fatal to their growth, as well as that baking and cracking of the soil frequently observed in midsummer on wet lands of a clayey nature. On drained fields we find no heaving from the ground of the roots of young plants by frost, to the great injury of an anticipated crop.

3. Draining secures a free circulation of air in the soil. Carbonic acid is brought, thereby, to the roots of growing plants and many insoluble silicates of the soil and manures commingled therewith are gradually reduced to a condition fit for their appropriation by growing plants.

4. It also raises the temperature of the soil,—a point of much consequence in cold latitudes. The sun's rays, no longer repelled by standing water, for water is warmed from below and not from above, sink into the soil and awaken there an energy that a drenched one never has.

5. Removing the surplus moisture which before partially passed

off by evaporation only, drainage lengthens materially the season—an important fact where the active vegetation does not much exceed four months, at longest, thereby rendering possible the production of cereals on grounds where previous to drainage poor aquatic grasses only could be produced.

OPEN DRAINS.

There are two methods in use for the removal of the surplus water from a soil, viz:

1. By open ditches.
2. By underground drains.

The first is the primitive means, suggested by nature itself, and under some circumstances, the one to be preferred. It is liable however to important objections.

1. It mars the beauty of a field to divide its surface into patches, by open trenches crossing it at frequent intervals and in all directions.

2. These occasion great inconvenience in tillage operations, for it is next to impossible to cultivate the ground to their edges, and if done this is accomplished at increased expense.

3. Unless made very slanting—a course to which grave objections may be urged—the sides of open ditches are almost sure to be precipitated by frost every winter, to the obstruction of the drain and the necessitating an annual outlay for keeping clear the channel. As this clearing is oftentimes impossible, until late into the summer, imperfect drainage occurs at the very time of all others when it is most deleterious.

4. And these open ditches occupy much land which might otherwise be devoted to cultivation. In a field of ten acres, drained in this way, it will be found upon examination that about one acre is lost in the ditches. Therefore, in estimating the expense of draining by this system, the value of the land thus taken becomes an important item in the calculation.

But, notwithstanding these objections, the open ditch is oftentimes the one to be preferred, and is the cheapest where land is abundant and the materials for underground draining are scarce and dear; or where from the peculiar situation of the land, a surrounding, open, catch-water ditch will insulate and dry it, there this drain will generally be more desirable than any other.

We find, however, that where land has become dear and its

cultivation is carried to a high state of pefection, the open trench is generally discarded and underground drains are preferred. The reason of this is obvious, as by their use the objections just suggested to open ditches are no longer encountered. Natural beauty, a saving of land and convenience in tillage operations, all favor their adoption. Over a field thus drained a team may pass from end to end without interruption; the furrows may extend across it unbroken, and over it may pass, with no obstruction, the harrow, the cultivator, the mower, the hay-tedder and the horse-rake.

UNDERDRAINING.

An underground drain may be made of anything that will admit water and preserve an open channel for its passage.

1. The Romans, as already stated, sometimes used brush and even straw. I have known meadow hay employed for this purpose in our own day. All such materials however soon perish and are mentioned here rather to deprecate than to commend their use.

2. On stiff, adhesive soils underground drainage is sometimes effected by drawing a pointed plug through the ground, at the desired depth, which forces open a channel of its own size. This generally remains open for some years. The plug, attached to a sharp, flat, perpendicular standard, joined to a beam, like that of a plow, is drawn through the soil, sometimes by means of a movable capstan, and at others by teams. This method has been used in England, and somewhat upon the prairies of the west. I imagine, however, that its cheapness is more than counterbalanced by its want of durability, and that this consideration, joined to that of the character of our soils, will preclude its adoption among us.

3. Poles, laid in pairs a few inches apart and covered with a board, a slab, or a third pole, have often been used with success. Our venerable friend Levi Bartlett, showed me drains of this kind upon his farm, in Warner, which had done service for a long period. But while they are cheap, the materials of which they are made are more or less perishable and their channels liable to obstruction by field mice and silt.

4. Stones have been used longer and perhaps more than any other material. We have at least two thousand years' experience with them, demonstrating conclusively that of these may be con-

structed drains of the most durable character, as they never decay.

Drains of this material have been made in various ways, governed more or less by the shape of the stones, the character of the ground and the fancy of the builder. Sometimes rounded cobbles have been thrown promiscuously into the bottom of an open trench, to the depth of a foot or more, and then covered, first with a sod, and afterwards to the level of the ground with earth. Thus constructed they answer a good purpose for awhile and sometimes for many years, but are liable to stoppages, particularly if the fall be slight.

A better and more common way is to build, first, a small covered water course, of selected stones, and around this, to the depth of a foot or more, pack others of indiscriminate sizes, afterwards filling, as before, the trench to its top with earth. A man must be tough and well nigh immortal to outlive the usefulness of such a drain, for, if well made in compact soil, his grandchildren and great grandchildren will arise and call him blessed for leaving to them such an inheritance. The abundance of stones on many of our farms, and the desirableness of their removal, will long render this drain a popular one.

5. But the best drain of any, all things considered, is the tile drain, and, in localities where its cost is not a serious objection, will eventually be more used than any other. Tiles are simply pipes, generally about a foot long, made of clay and burned in a kiln, like ordinary brown pottery. They are of various forms. Some present a section resembling a horse shoe, and for that reason are called the horse-shoe tiles; bottoms of the same material accompany these, upon which they are laid. Some are simply round pipes, with collars over the joints to keep them in place. Others, called sole tiles, and having an egg-shaped bore, are externally flat upon the bottom with circular top and sides. There are still other kinds, and among them one made at Pembroke, in this state, in the same manner and of the same material as an ordinary brick, but with a longitudinal semi-circular groove in one side. The bore is completed by laying them one upon the other and breaking joints as the conduit is extended. These all answer a good purpose.

The round tile may perhaps be laid with the least care, as the collars keep the joints in place, but no drain should be laid otherwise than carefully. Thus far, the sole tile has been more com-

monly used in New Hampshire than any other, and always, I believe, with success. The Pembroke is probably the most durable of any, but its present cost is about double the price of the sole tile—that of the former being about three and a half cents per line or foot, and that of the latter, about two at the place of manufacture. In favor of the tile drain may be urged:

1. Its durability. It has not been in use long enough to determine precisely how long it will last, but experience already shows that it will do good service for generations.

2. Less excavation is required for this than for stone drains, occupying as it does but little space, and allowing the ditch to narrow as it deepens, to a width at the bottom little more than that of the tile itself, thus diminishing materially the cost of the drain.

3. The trench once prepared, tiles are laid at very slight expense, compared with that required in the construction of stone drains. They are simply to be placed end to end in the bottom of it, and then covered with earth.

4. If at any time an obstruction occurs, it is readily found and easily removed by digging down at the point where it appears and clearing the obstructed tiles.

The only serious objection to this kind of drainage is the expense of the necessary tiles. I am not aware that any durable substitute, save stone, has been found for them. It has, however, more than once occurred to me that conduits of wood might in some places be used successfully. I have upon my own farm a drain of two-inch white pine plank, through which the water flows constantly, and which is as sound to-day as it was when laid in 1856, fourteen years ago. That pipes of wood, similar in shape and size to those made of clay, might be manufactured in many localities at a comparatively slight expense there can be no doubt. If laid in soils of pretty even temperature and continually wet, they would doubtless last for many years. The economy of their use may be problematical and can be satisfactorily settled only by experience. The experiment is worth the trial.

HOW TO DRAIN.

Several points should be definitely settled before entering upon any considerable work of underdrainage, otherwise much time and money may be wasted, and the object sought imperfectly attained, if at all. If possible, a comprehensive plan of the whole work should be made before a single trench is opened.

Besides this, a little enthusiasm in the work is important — a settled feeling, for the time being, that the present is a more important enterprise than all others — an enthusiasm akin to that manifested by the Emperor Dioclesian, (A. D. 305) when, after having abdicated the throne and retired to his villa, sick of the cares of state, he was asked to resume the purple and replied, "If you could see the cabbages I raise in my garden you would not ask me to take a throne." Such an enthusiasm puts things through and ensures success. Thus prepared,

1. The first step should be to determine, from a careful examination of the ground, the inclination of its surface and the sources of the water to be removed. Sometimes the piece to be drained is a basin, surrounded by hills forming a water-shed which turns the rainfall of many acres upon a very few. At other times, it is drenched by springs overflowing at the confines of it. In either case a simple, isolating, border trench will generally intercept the flowage and be found sufficient.

Sometimes it is underlaid by a subsoil impervious to water, or is of a clayey nature, admitting percolation but slowly, or is kept continually wet by springs gushing up from below. Here a border trench would do little good and a system of cross drains must be laid.

At other times the land is an abandoned channel or low alluvial ground near a river and is kept wet by springs, or occasional inundations, or by both. Here, a single open ditch may perhaps suffice; more probably, however, border and cross drains will be found necessary.

2. The second point will be to secure a sufficient outlet for the drains and determine its location. Without this all hopes of success will be vain. It must be low enough to secure a free discharge of all of them, and, if possible, at the lowest point of the field, less excavation being required for it here than elsewhere.

3. The third point to be settled will be the location of the main channels into which the laterals, more or less numerous, may enter. A careful study of the topography of the field will generally determine this without difficulty, though sometimes the aid of a water level or even a theodolite may be requisite.

4. These three points having been determined, viz: the origin of the offending water, the best place for it to leave the field and the location of the main conducting channels, the problem is about solved. It only remains to settle where the laterals shall be

placed, which a little farther observation of the ground and its formation will readily determine.

5. The surface of land to be drained often lies at a considerable angle to the horizon, and the question has been much discussed whether, in such cases, drains should be laid up and down or lengthwise of the slope. A little practical experience, and even a little observation will prove that the former is the true course, as much of the water to be removed will miss them, if laid in the other direction, by passing above or below them in its flow down the hill; whereas if it be a long one, and the drains of good depth, most of it will find its way into them ere it reaches the bottom.

6. That a drain must have some fall is self-evident. What that shall be is not so plain, and no exact rule of universal application can be made to govern it. If the inclination be too slight, the flow of the water will be sluggish and the channel liable to obstructions; if too great, whenever a large quantity of water is to be discharged, the lower part of the conduit may be crowded beyond its capacity of discharge and some of the water be forced out at the joints, drenching the land about it.

Economy requires that the inclination be such as to insure a free flow of water, for up to the point just alluded to, in proportion as the velocity of the flow is increased the size of the drain may be lessened and its cost diminished. An ordinary tile drain, falling three inches in one hundred feet, will discharge less than half as much water as one falling one foot and but about one-fifth as much as one falling four feet.

Sometimes the ground to be drained is so level, and the distance to the outfall so great, that the possibility of any drainage is problematical. In such cases the question arises, what is the least fall sufficient for the purpose? This was presented to your speaker for solution some fifteen years ago, upon his farm in Concord. About thirty acres of land, nearly level, had for three generations been considered worthless and lain unproductive for want of drainage. The water stood upon it about six feet above the summer height of Merrimack river, where was its outfall, distant about three-fourths of a mile, (three thousand five hundred and eighty-nine feet), and affording an average descent of only one inch in every fifty (49 61-72) feet, to begin with, and diminishing, of course, according to the depth of the drainage ultimately effected. Was drainage practicable in this case, and was the experiment

worth the trial, at an expense of five or six hundred dollars? It was determined to make, it at all events, and made it was.

The impracticability of maintaining an open ditch, varying in depth from seven to fourteen feet and a half, for the first forty-six rods, near the river and in soft alluvial soil, suggested a covered drain of two-inch white pine plank, twelve inches wide and eight inches high, inside measure, for that distance from the outlet. This was constructed and laid on an average rise of one inch in fifty-one feet, which, considering the frequent rise of the river above the mouth of it, at all seasons, has proved none too much. For the remaining distance of two thousand eight hundred and twenty-two feet, an open ditch was cut and much of the way with little if any fall.

Experience soon demonstrated two things, viz:

1. That a given amount of water would pass through a smooth covered drain in less than half the volume it would through a shallow open ditch of uneven bottom, and

2. That, in this instance, drainage by the latter was but partially successful, owing to frequent obstructions, resulting from a falling down of its sides, sedimentary deposits by freshets, and a rank growth of flags in the bottom, which every summer was sure to produce. A farther sloping of the banks nearly obviated the first difficulty, but the other two remained.

The thought of boarding the bottom of this open ditch, one day suggested, seemed almost an inspired one, promising, as it did, not only to facilitate its cleansing, when necessary, but to prevent altogether the growth of obstructing aquatic vegetation and afford a smooth bottom for the water to flow over without friction. This was done for some three-fourths of the whole distance and the fascinating dream was realized—until the next spring freshet brought a new deposit of sand, from which sprung a new crop of flags, and renewed the nuisance, which, it was supposed, had been abated forever. For these evils the covered drain has been found the only practicable remedy, and when fully completed will doubtless insure a satisfactory drainage of the meadow to an average depth of three feet; thereby showing the practicability of a fall of one inch in every one hundred feet. Were the same experiment to be repeated, even a better result than this could be reached.

At what depth drains should be laid admits of no one definite answer. They have been placed at various depths, from one to

four feet, and in all instances have done good. They must be low enough, however, to sink the water table sufficiently below the surface of all parts of the field, to insure everywhere a wholesome soil.

This depth will depend upon the character of the ground. If a porous one, through which water percolates readily, it may be less than when compact, admitting it but slowly; or when spongy, where capillary attraction raises the water to a considerable height above the drains. The use to which the land is to be devoted is also a consideration to be regarded. If intended for grass only there is less need of deep drainage than if cereals are to be raised upon it. But, whatever the soil or the future crops, every drain must be below the reach of the plow or the frost.

Some of our most experienced drainers have fixed upon four feet as the depth to be generally adopted, ranging above or below it, as circumstances may suggest. If to any this shall seem an unnecessary one, it may be added that the lower drains are sunk, the farther they will draw, and that their frequency may be diminished as their depth is increased.

On ordinary soils, if laid at this depth, they might be placed from fifty to sixty feet apart and afford a good drainage. On clayey soils this distance would be too great and should be materially lessened.

Such are some of the principal points arising upon an examination of the important subject of drainage. If our superficial allusions to them shall stimulate you to a further consideration of it, our end will have been attained.

Our distinguished historian, Mr. Bancroft, speaks of the life and occupation of the Pilgrims, as "a plain country life and the innocent trade of husbandry." Such are ours. To us has been committed the care of the land. Let us thank God that we are "landed proprietors," and appreciate our good fortune. The world has never before seen such an agricultural people as the last two centuries and a half have reared on American soil—an intelligent yeomanry owning the farms it tilled. Before, an idle aristocracy had everywhere possessed the land and appropriated the fruits that other hands had raised. Even to-day thirty thousand persons own the whole territory of England. The other nineteen millions get on as best they can. Here, how different! Ten years ago New Hampshire alone had thirty thousand farms and every man a farm who wanted one.

Something elevating and strong comes from a sense of the ownership of land. This is not, like everything else, perishable property, passing from one to another by mere delivery. It is, as its name asserts, real estate, conveyed only by formal deed, signed, sealed, witnessed, solemnly acknowledged and delivered. A man stands independent and consciously a man, upon the acre he owns. He is an acknowledged proprietor of a part of the great globe the Almighty has hung in air. His acre is to him a realm, and more than a hundred and sixty square rods of earth's surface; is, rather, extending inward and outward both, an immense pyramid, whose shaft, like the hollow cone in Dante's Inferno, reaches downwards with diminishing proportions to where gravity dwells, and whose base with spreading dimensions continues upwards through infinite space even to the confines of other spheres.' To what degree soever we appreciate our inheritance and improve our opportunities we meet manfully life's duties and deserve life's success.